

Shankersinh Vaghela Bapu Institute of Technology
Mechanical Engineering Deptt.

Sub. : Elements of Mechanical Engineering
(2110006)

Chapter No. 6:-Steam Boiler

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❖ INTRODUCTION

- ▶ **Boiler** : “ It is a closed vessel in which the heat produced by the combustion of the fuel is transferred to water for its conversion into steam at the desired temperature and pressure.
- ▶ A boiler is a device used for generating:–
 - (a) Steam for power generation
 - (b) Hot water for heating purpose

❖ Boiler according to I.B.R

- ▶ According to the Indian Boiler Regulation (I.B.R) a boiler is a closed pressure vessel with capacity exceeding 22.75 liters used for generating steam under pressure.

❖ What is the difference between steam boiler and steam generator?

- ▶ Technically speaking a **steam boiler** consists only of the containing vessel and convection heating surfaces.
- ▶ While **steam generator** covers the whole unit of water wall tubes , superheaters , air heaters and economizers .

❖ Classification of boilers

- **Horizontal , Vertical and Inclined boiler**
 - (a) If the axis of the boiler is horizontal, it is called the **horizontal boiler**.
 - (b) If the axis of the boiler is vertical, it is called the **vertical boiler**.
 - (c) If the axis of the boiler is inclined, it is called the **inclined boiler**.

Continue....

➤ Fire tube and Water tube boilers:-

(a) The boilers in which the hot gases are inside the tubes and water is surrounding them is called **fire tube boiler**.

(b) The boilers in which the water is inside the tubes and the hot gases surrounding them is called **water tube boiler**.

Continue....

- **Externally fired and internally fired boilers**
 - (a) In the boiler if the fire is outside the shell, that boiler is known as **externally fired boiler.**
 - (b) The boiler in which the furnace is located inside the boiler shell it is known as **internally fired boiler.**

Continue....

➤ **Forced Circulation and Natural circulation boiler:–**

(a) In the boilers if the circulation of water is done by a pump then they are known as **forced circulation boilers**.

(b) In the boilers of the circulation of water takes place due to difference in density resulting from difference in temperature, it is known as **natural circulation boilers**.

Continue....

➤ High ,medium and low pressure boilers:

(a) It is one in which the working pressure of the boiler is **more than 25 bar**, it is known as **high pressure boilers**.

(b) It is one in which the working pressure of the boiler is between **10 to 25 bar**, it is known as **medium pressure boilers**.

(c) It is one in which the working pressure of the boiler is between **3.5 to 10 bar**, it is known as **low pressure boilers**.

Continue....

➤ **Stationary and portable boilers:**

(a) The boilers which can not be transported easily from one place to another are called **stationary boilers**.

(b) The boilers which can be transported easily from one place to another are called **portable boilers**.

Continue....

- **Single tube and multi tube boilers:**
 - (a) The Boiler having only one fire tube or water tube in the boiler then it is known as **single tube boiler**.
 - (b) The Boiler having two or more fire tube or water tube in the boiler then it is known as **multi tube boiler**.

❖ Simple Vertical Boiler:

- ▶ It is **vertical** .
- ▶ It is **portable** with very small floor area.
- ▶ It is a **water tube boiler**.
- ▶ It is **internally fired**.
- ▶ It is a **multi tube boiler** with two cross tubes.
- ▶ It is **naturally circulated**.
- ▶ It is **low a low pressure boiler**.

Simple vertical boiler

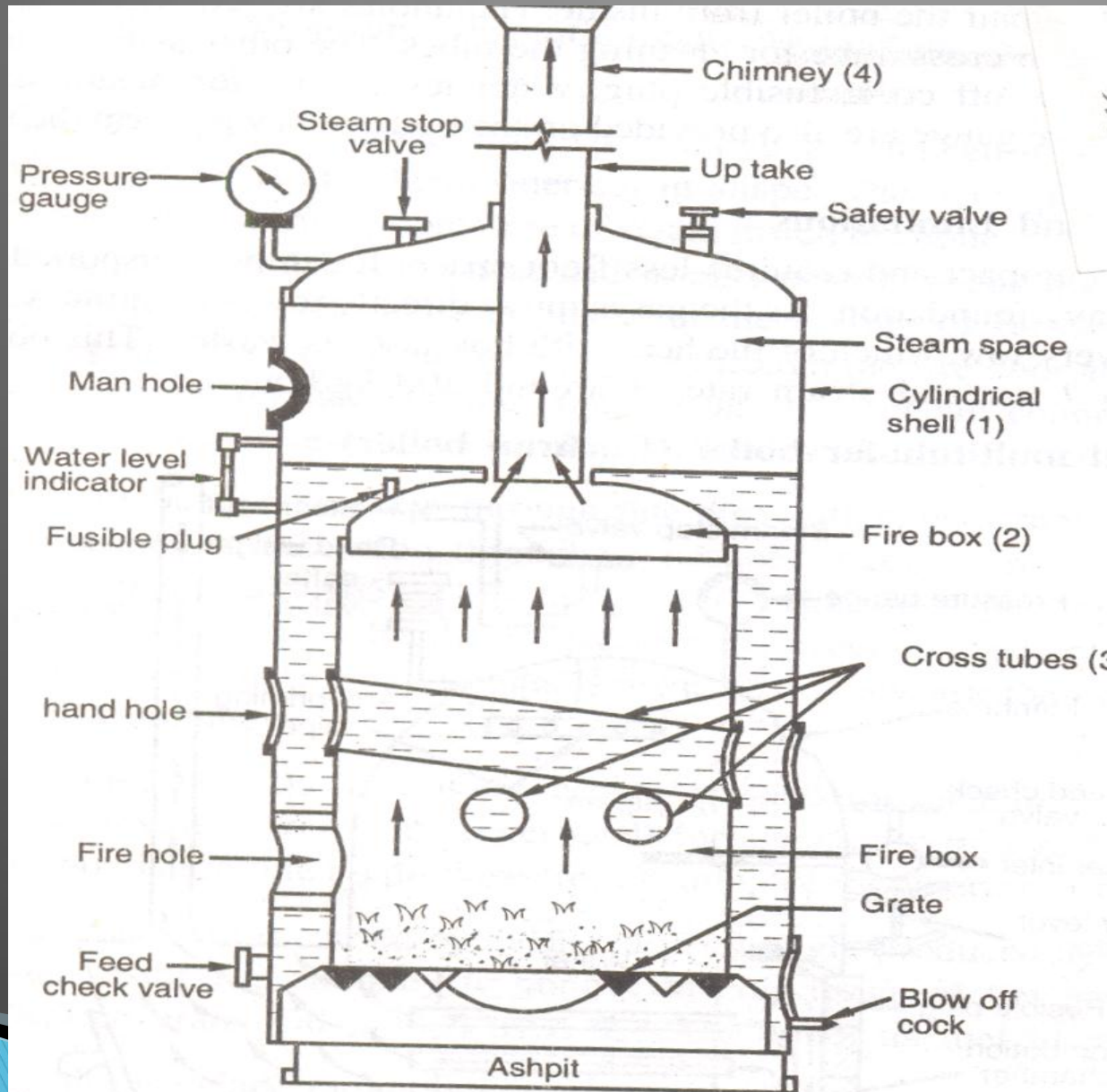


Fig. 5.14 : Simple vertical boiler

Cochran boiler

5.7.2 Vertical multitubular boiler (Cochran boiler) :

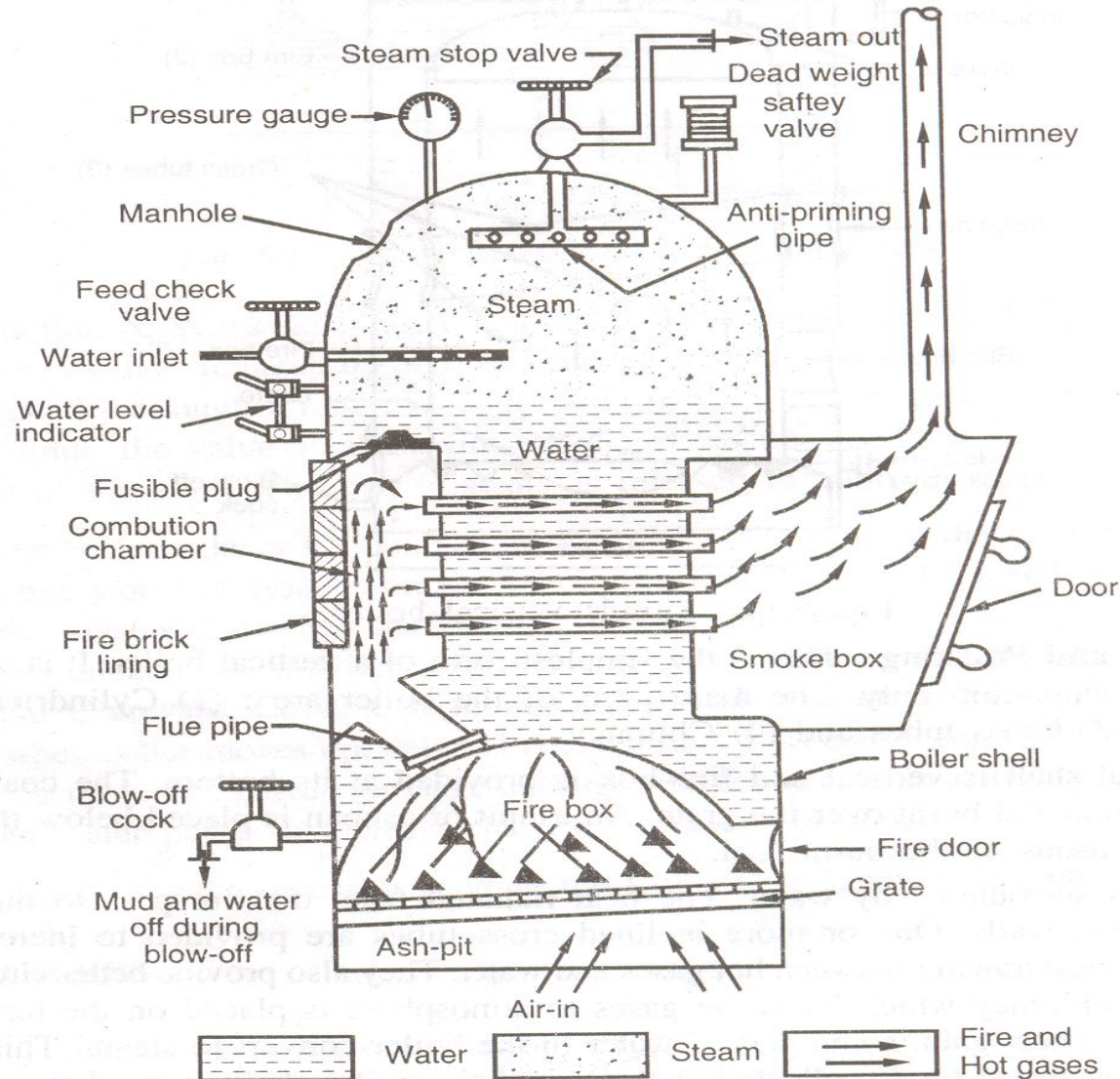


Fig. 5.15 : Cochran boiler

CHARACTERISTIC OF COCHRAN BOILER

- ▶ Vertical
- ▶ Fire tube
- ▶ Multi tube
- ▶ Internally fired
- ▶ Natural circulated boiler
- ▶ Portable
- ▶ Low pressure boiler

❖ Specifications of Cochran boiler

- ▶ Shell diameter = 2.75 m
- ▶ Height = 5.75 m
- ▶ Working pressure = 6.5 bar
- ▶ Steam capacity = 3500 kg/hr
- ▶ Heating surface area = 120 m²
- ▶ Efficiency = 70 % to 75%

Advantage -disadvantage of cochran boiler

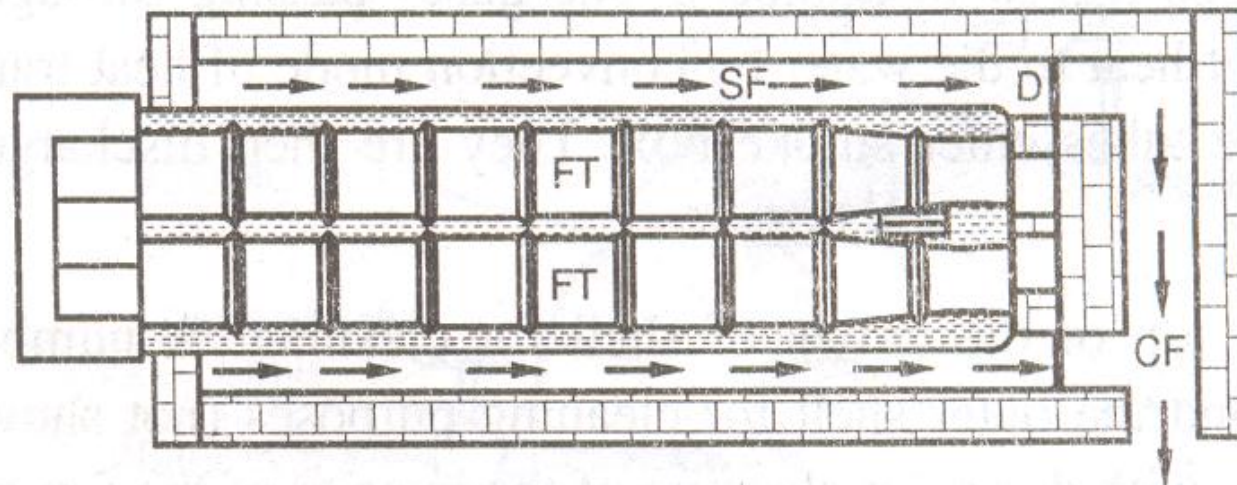
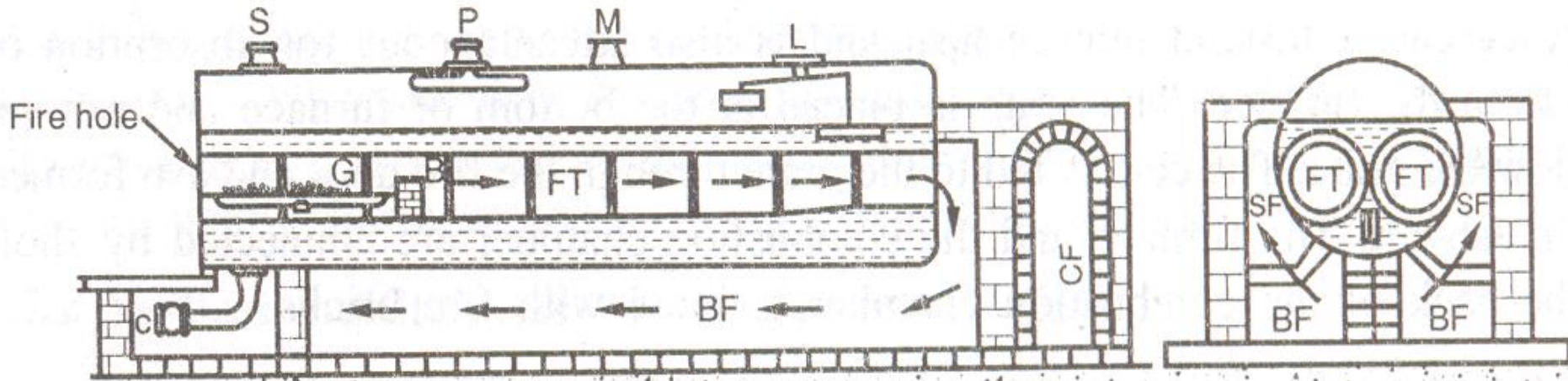
Advantage

1. Compact
2. Portable
3. Low initial cost
4. Easy instalation
5. Any types of fual can be used

▶ Disadvantage

- ▶ Steam raising capacity is low due to verticle design
- ▶ Poor efficincy

Lancashire boiler



- B - Brick bridge
- G - Grate
- FT - Furnace
- BF - Bottom flue
- SF - Side flue
- CF - Chimney
- P - Steam control
- L - Low water level
- S - Safety valve
- C - Blow-off cock
- D - Damper

Fig. 5.16 : Lancashire boiler

Characteristic of Lancashire boiler

horizontal

stationary

fire tube

internally fired

multi tube

natural circulation of hot gases

medium pressure

Specification of Lancashire boiler

- ▶ Shell diameter 2 to 3 metre
- ▶ Length of shell = 7 to 9 m
- ▶ Max pressure 16 bar
- ▶ Steam capacity 9000 kg/hr
- ▶ Efficiency = 50 to 70 %

Advantage–disadvantage of lancashire boiler

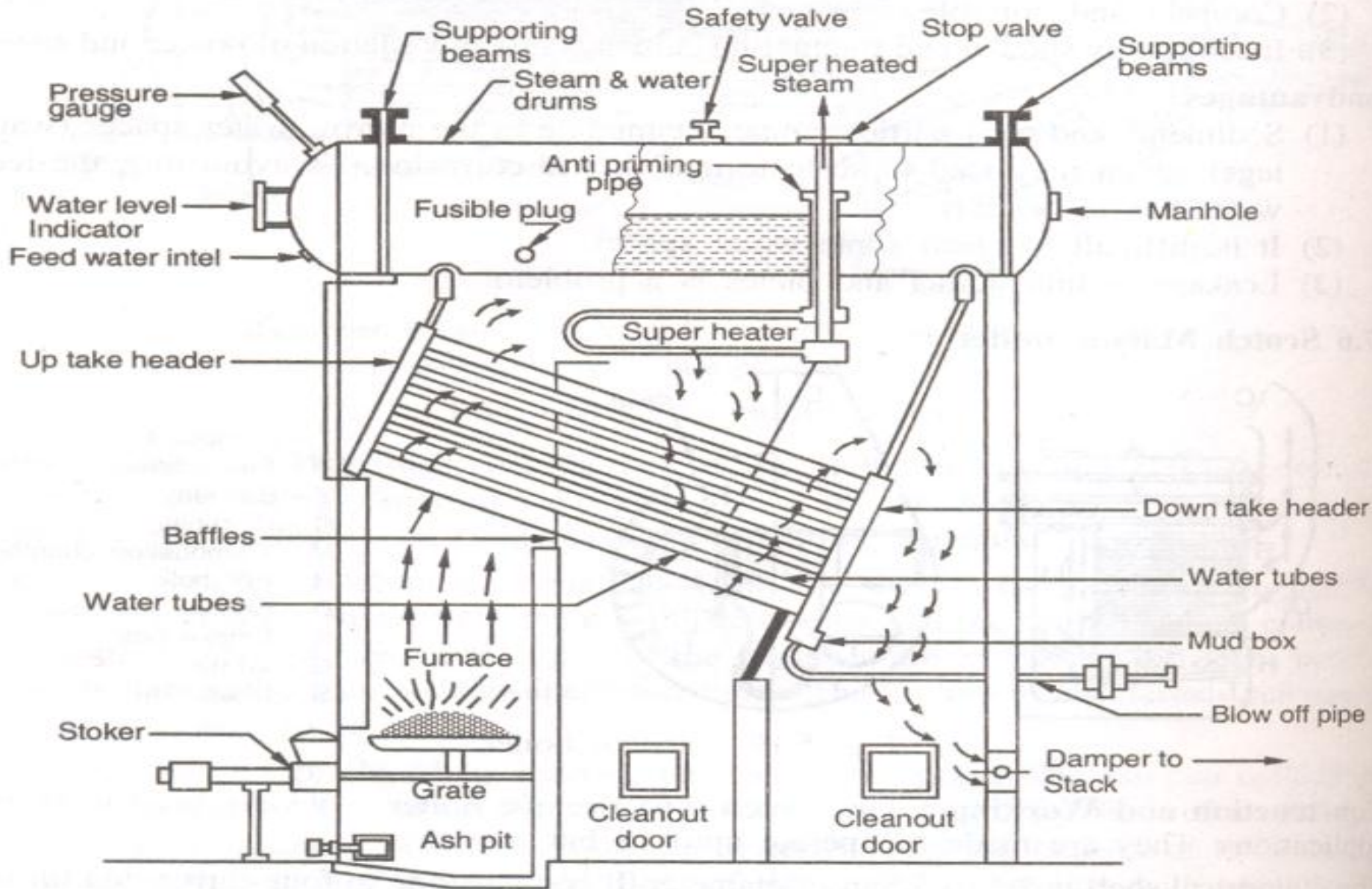
Advantage

- ▶ Heating surface per unit volume is high
- ▶ Fluctuation in the load can be easily met.
- ▶ Easy operation
- ▶ Low maintenance
- ▶ Easy to clean

Disadvantage

- ▶ Maximum working pressure limited to 16 bar
- ▶ Due to brick work more floor area is required
- ▶ Furnace placement is inside the flue tube, so grate area is restricted

Babcock and wilcox boiler



Babcock and Wilcox boiler

Specification of babcock and wilcox boiler

- ▶ Drum diameter = 1.22 to 1.83 m
- ▶ Length of drum = 6.096 to 9.144 m
- ▶ Size of water tubes = 7.62 to 10.16 cm
- ▶ Size of superheated tubes = 3.84 to 5.71 cm
- ▶ Maximum working pressure = 40 bar
- ▶ Maximum steam capacity = 40000 kg/hr
- ▶ Efficiency = 60 to 80%

Characteristics of babcock and wilcox boiler

- ▶ Horizontal
- ▶ Multitube
- ▶ Water tube
- ▶ Externally fired
- ▶ Natural circulation of water
- ▶ Forced circulation of air and hot gases
- ▶ Solid as well as liquid fuel used
- ▶ Stationary
- ▶ High pressure boiler

Advantage of babcock and wilcox boiler

- ▶ Higher steam generation capacity
- ▶ 2000 to 40000 kg/hr steam generation capacity
- ▶ Maintenance is easy
- ▶ Used in power station for producing large quantity of steam
- ▶ Less floor area required
- ▶ Greater operation safety

Boiler mounting and accessories

- ▶ **Boiler mounting:** mounting are devices ,which are necessary for the operation and safety of a boiler.
- ▶ **Accessories:** accessories are required for proper operation of the boiler and to increased efficiency of the boiler.

According to IBR(indian boiler regulation) following mounting should be fitted to the boiler

- ▶ Two safety valve
- ▶ Two water level indicator
- ▶ Pressure gauge
- ▶ Steam stop valve
- ▶ Feed check valve
- ▶ Blow off cock
- ▶ An attachment for inspector's test gauge
- ▶ Man hole
- ▶ Mud holes

Commonly used boiler accessories are

- ▶ Feed pump
- ▶ Injector
- ▶ Economizer
- ▶ Air preheater
- ▶ Super heater
- ▶ Steam separator
- ▶ Steam trap

Bourden tube pressure gauge:

Function: it is used for measurement of pressure in the boiler.

5.6.1 Bourden pressure gauge :

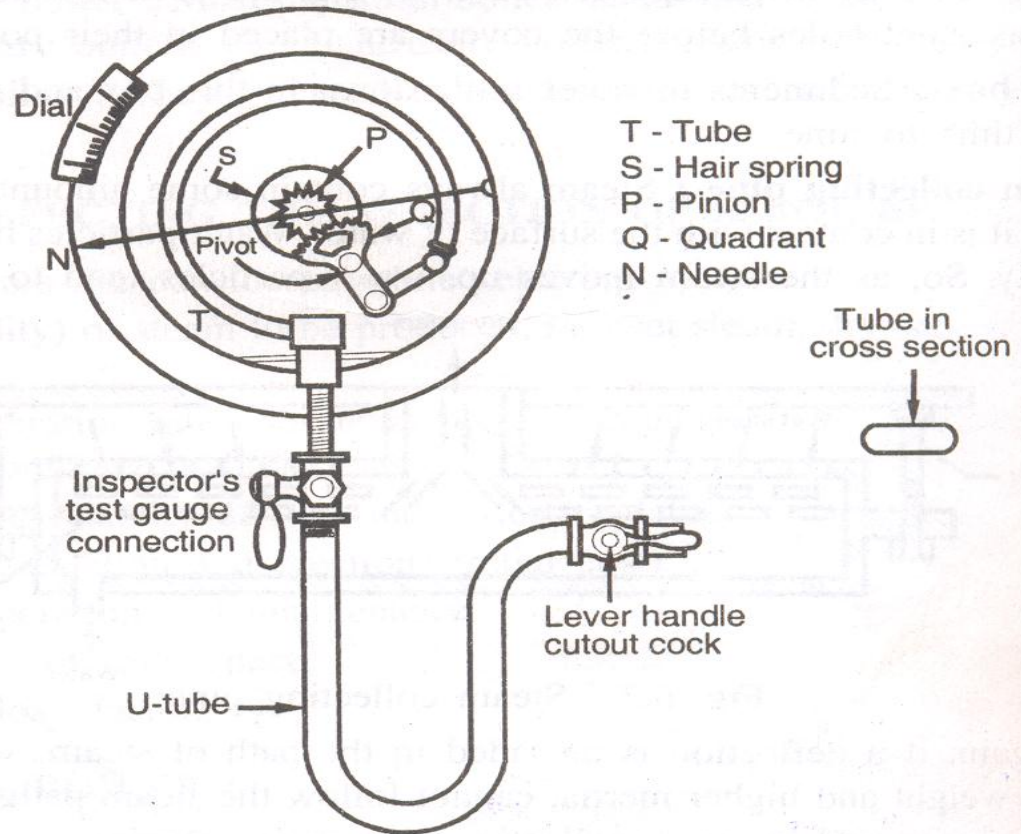


Fig. 5.4 : Bourden guage

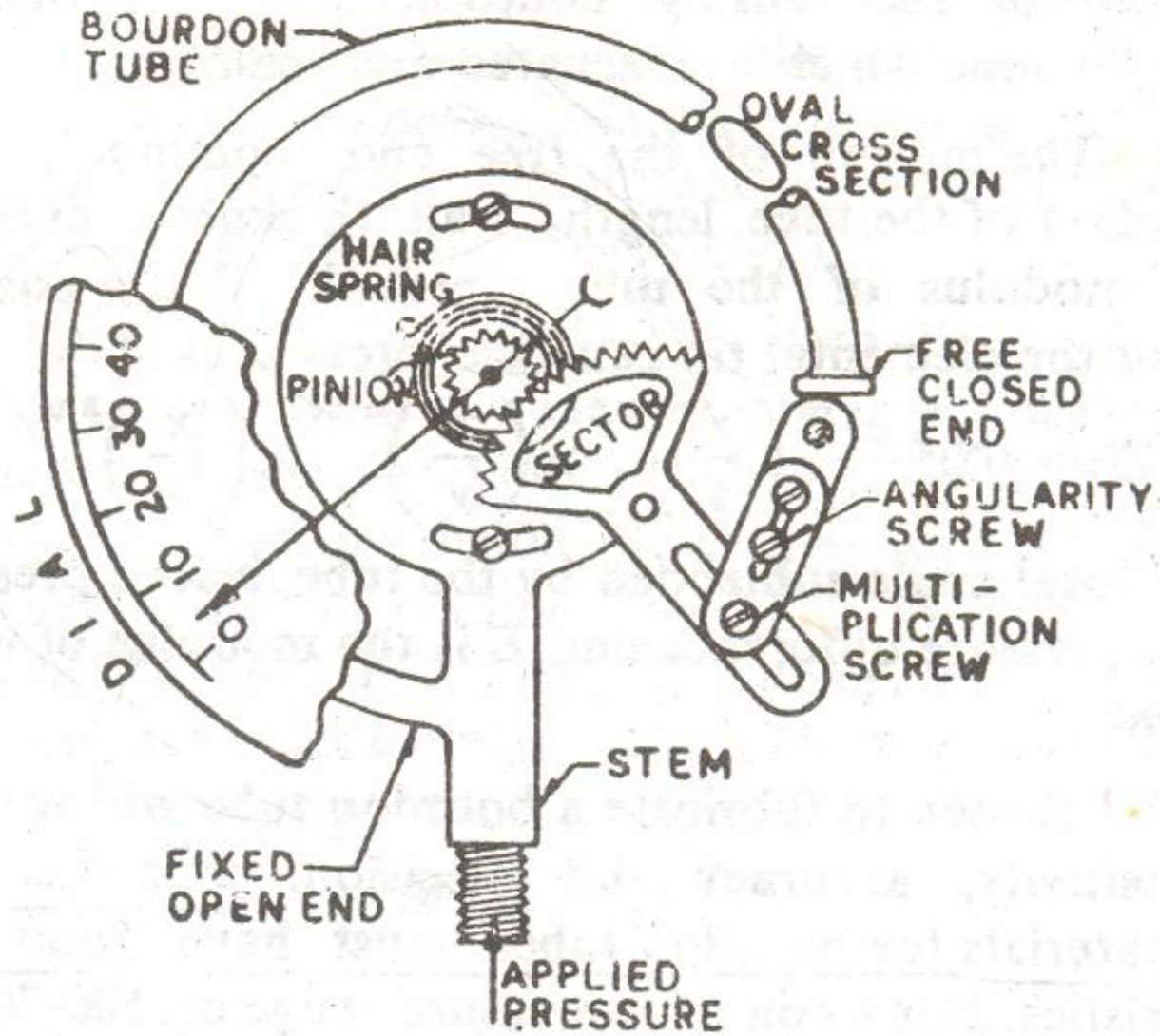


Fig. 8.19 Bourdon tube pressure transducer

Water level indicator

Function: Used to indicate water level inside boiler vessel

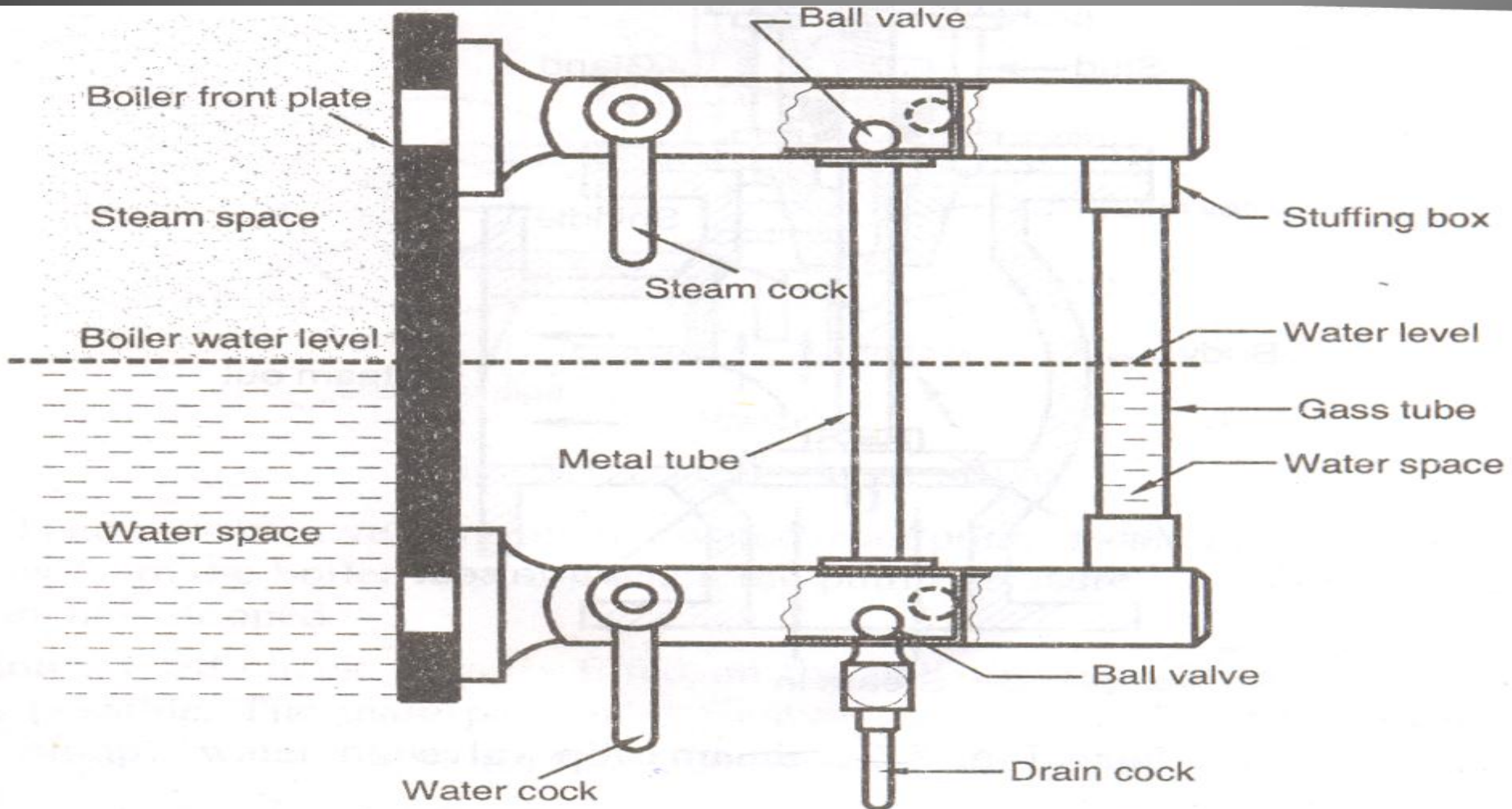


Fig. 5.5 : Water level indicator (Water gauge)

Steam stop valve

function: To regulate flow of steam from boiler to steam pipe

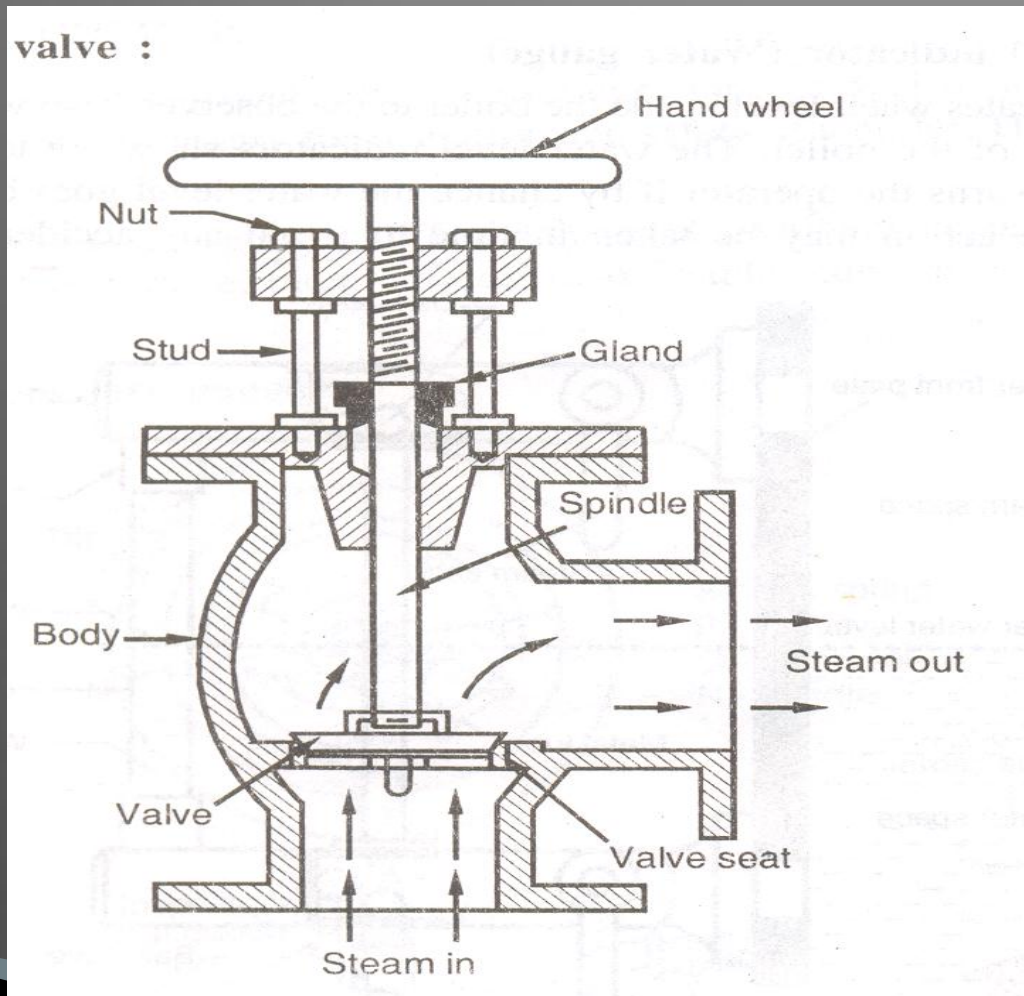


Fig. 5.6 : Steam stop valve

Feed check valve

function : To control the supply of water to the boiler and prevent back flow

Feed check valve :

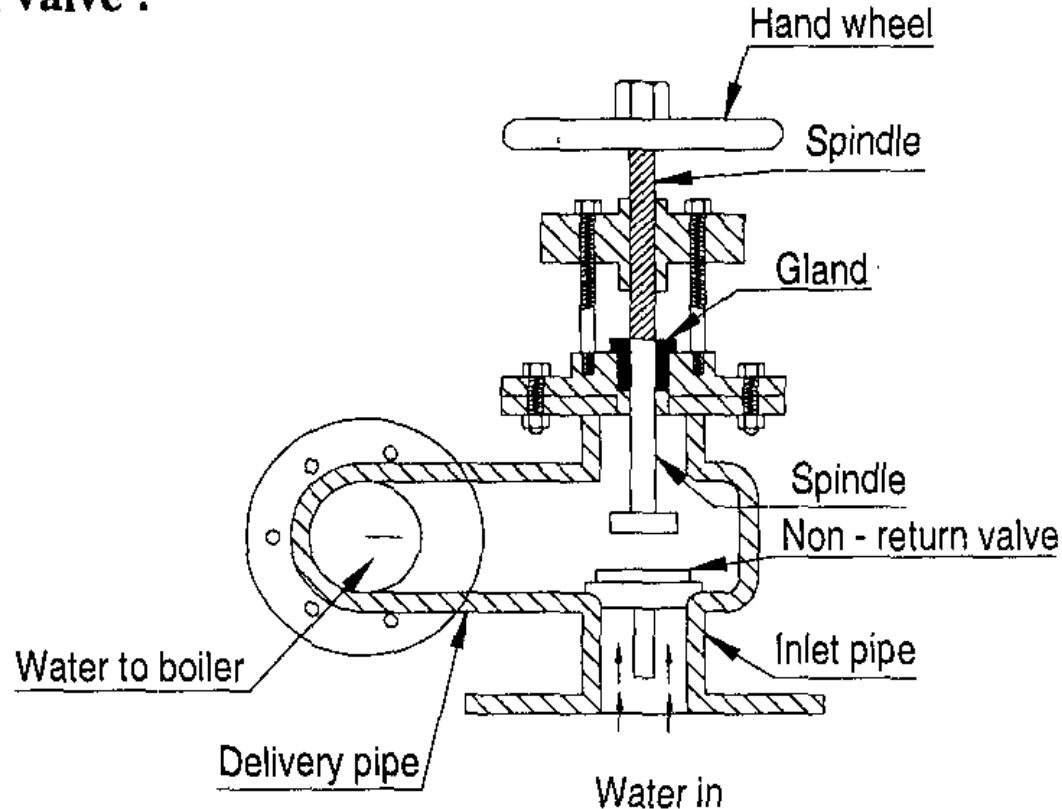


Fig. 6.18 Feed check valve

Blow off cock function:

- 1.remove water impurities
- 2.to empty the boiler for cleaning, inspection and repair

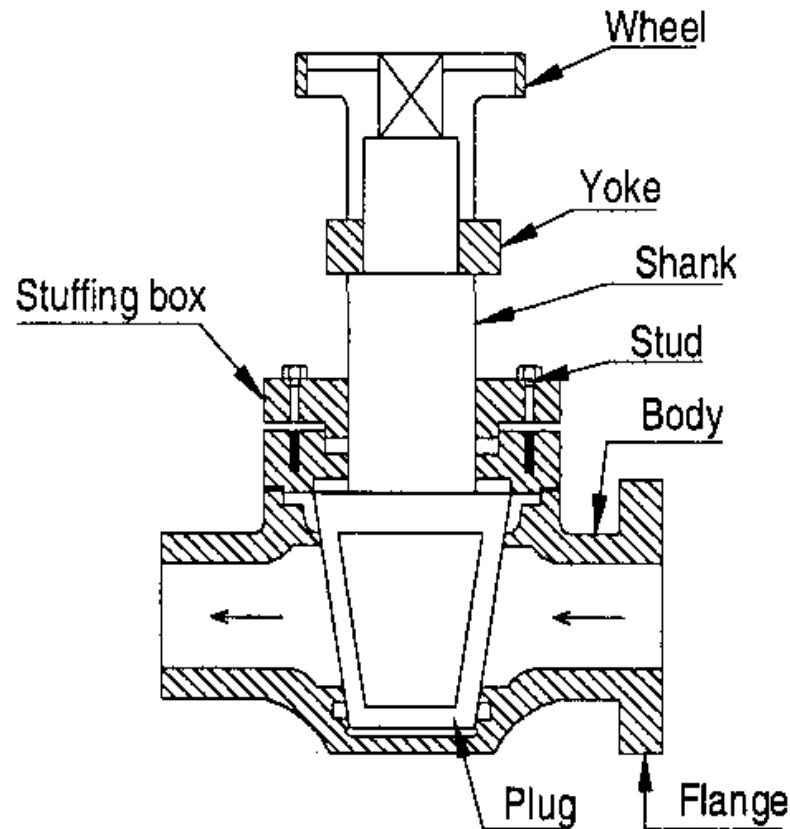
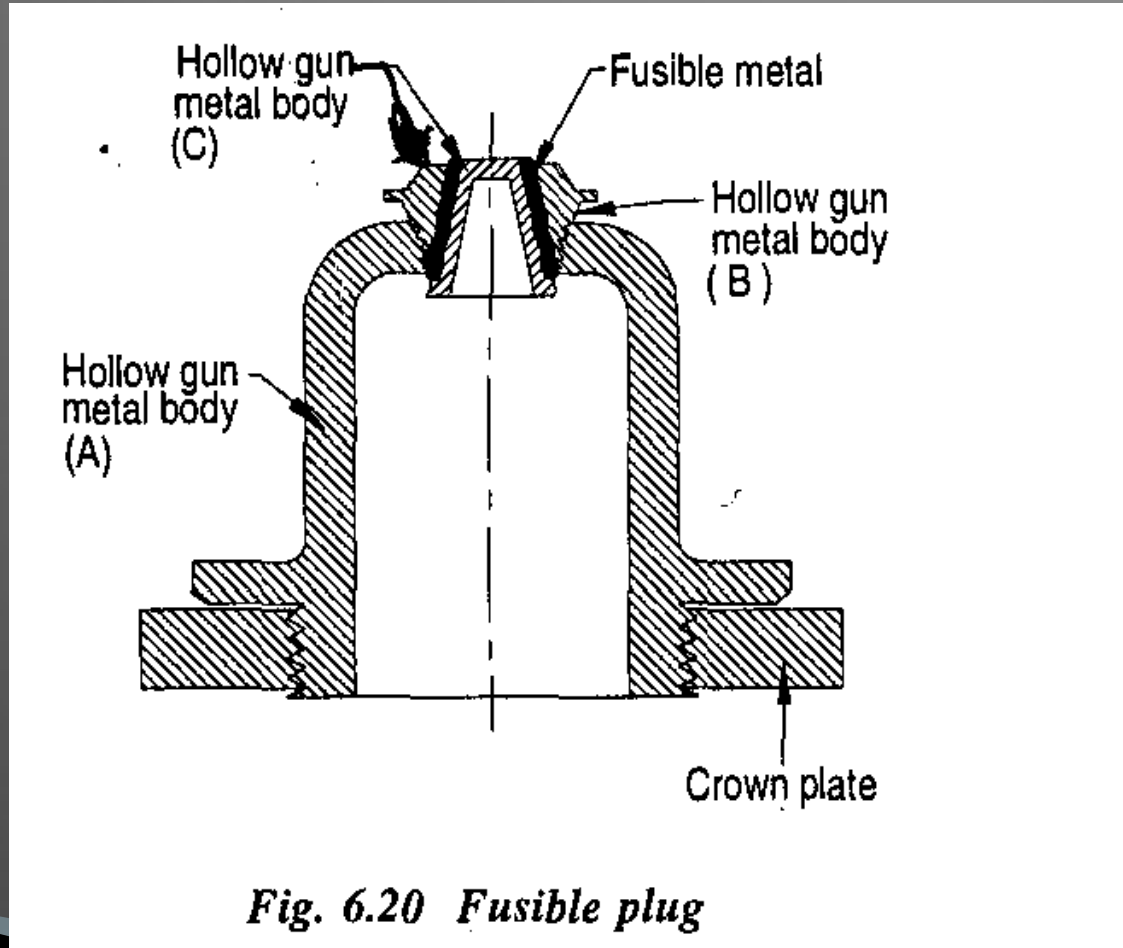


Fig. 6.19 Blow-off valve

Fusible plug

function : To protect boiler against over heating



Safety valve

function : to release the excess steam when pressure of the steam inside the boiler increase higher than safe pressure

safety valve may be classified as,

1. dead weight safety valve
2. lever safety valve
3. spring loaded safety valve
4. high steam low water safety valve

Dead weight safety valve

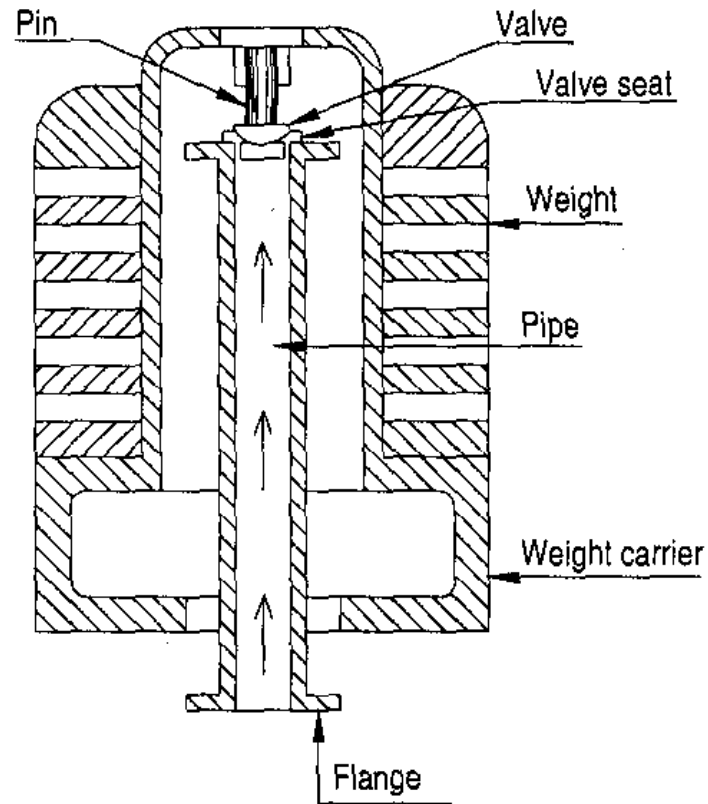


Fig. 6.21 Dead weight safety valve

Lever safety valve

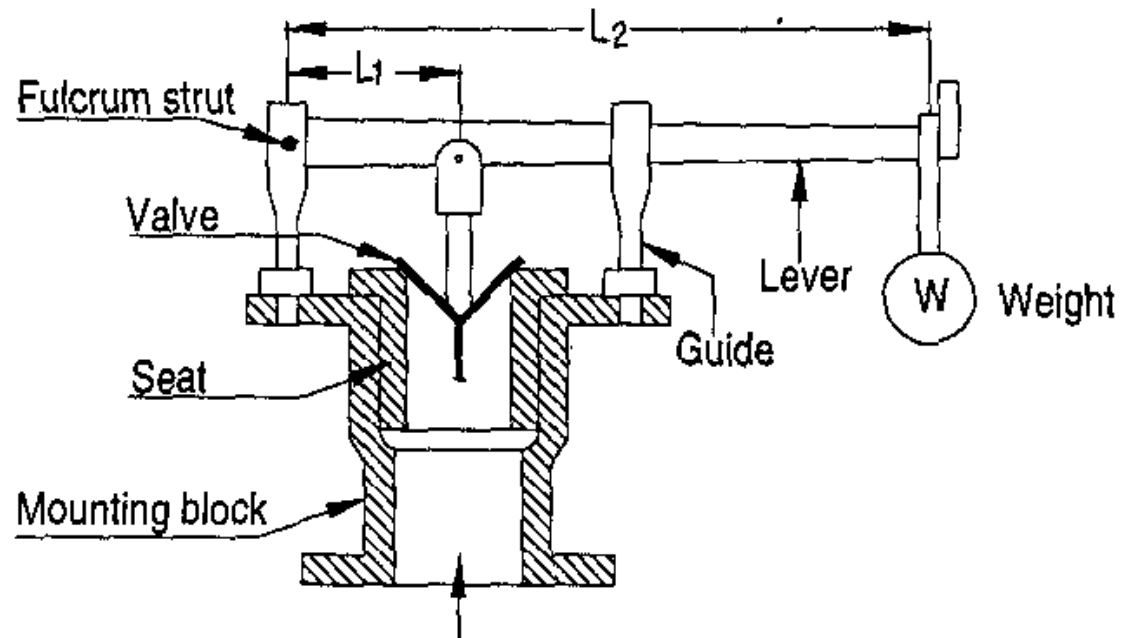


Fig. 6.22 lever safety valve

Spring loaded safety valve

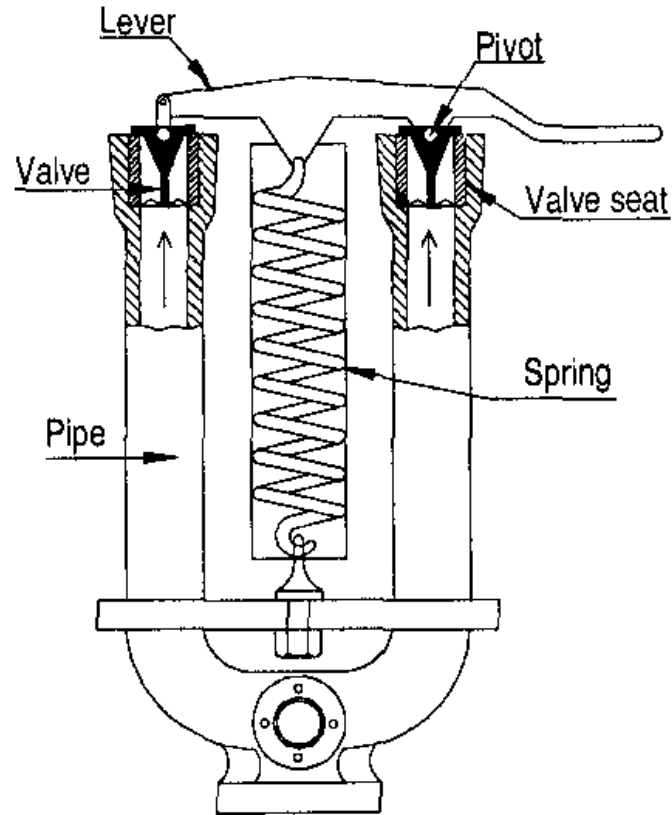


Fig. 6.23 Ramsbottom safety valve

High steam and low water safety valve

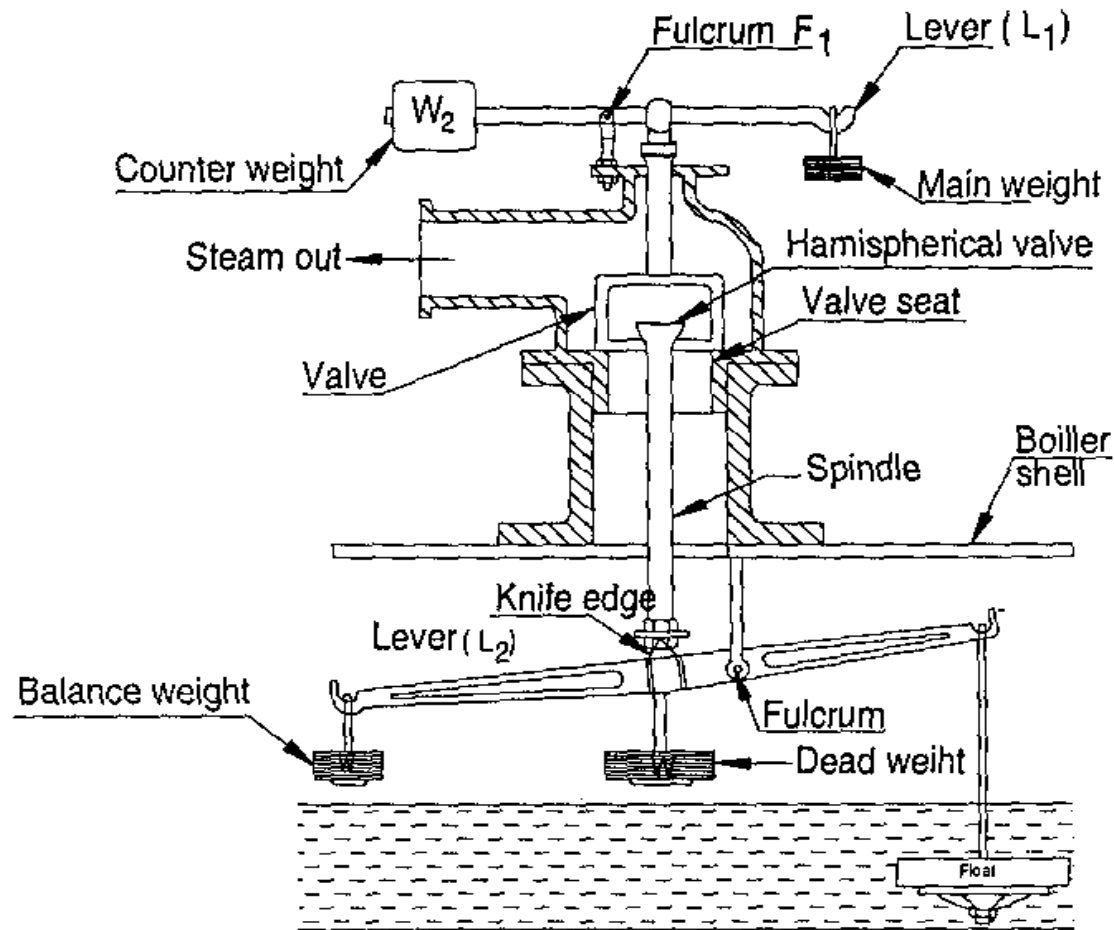


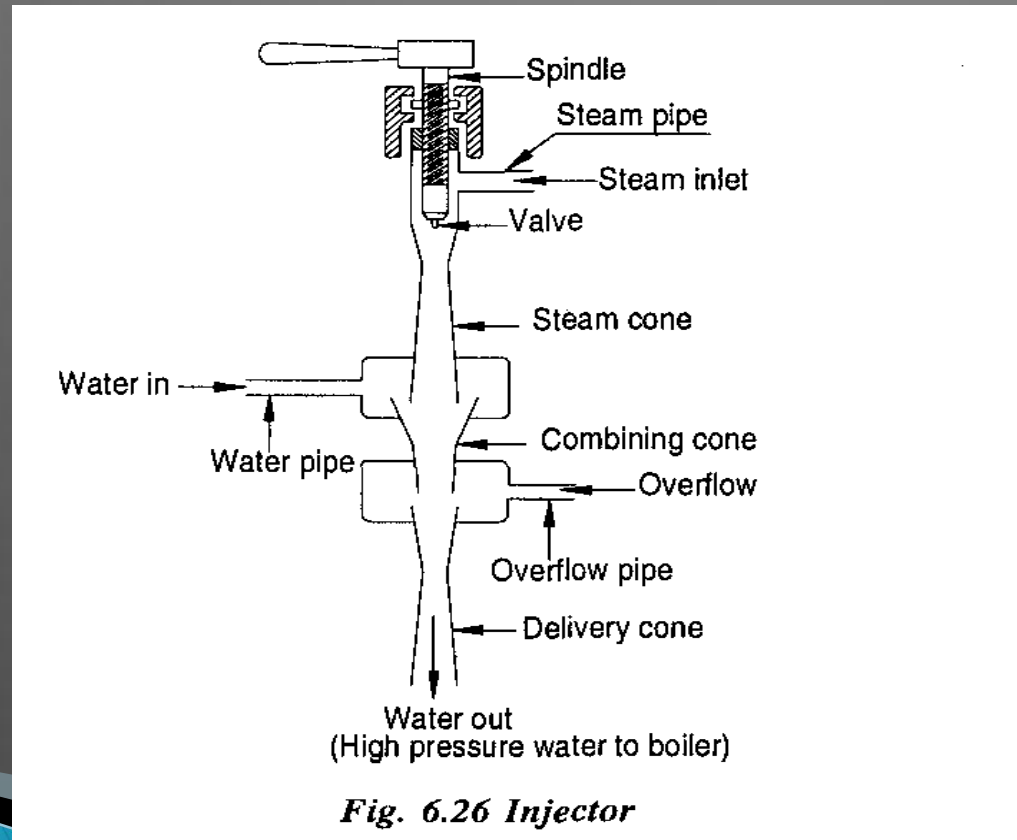
Fig. 6.24 High steam and low water safety valve

Feed pump:

To feed water in to the boiler through feed check valve pumps are classified as

1. reciprocating pump
2. rotary pump
3. centrifugal pump

Injector: To feed water in to the boiler it is commonly used for vertical and locomotive boiler it is also used where space for feed pump is not available



Feed water heater

to increase the temperature of feed water, before it enters in to the boiler

Feed water heater may be classified as

- ▶ 1. economiser
- ▶ 2. exhaust steam feed water heater

Economizer:

function: To increase the temp of feed water by using waste heat of fuel Gases

8.3 Economiser : ✓

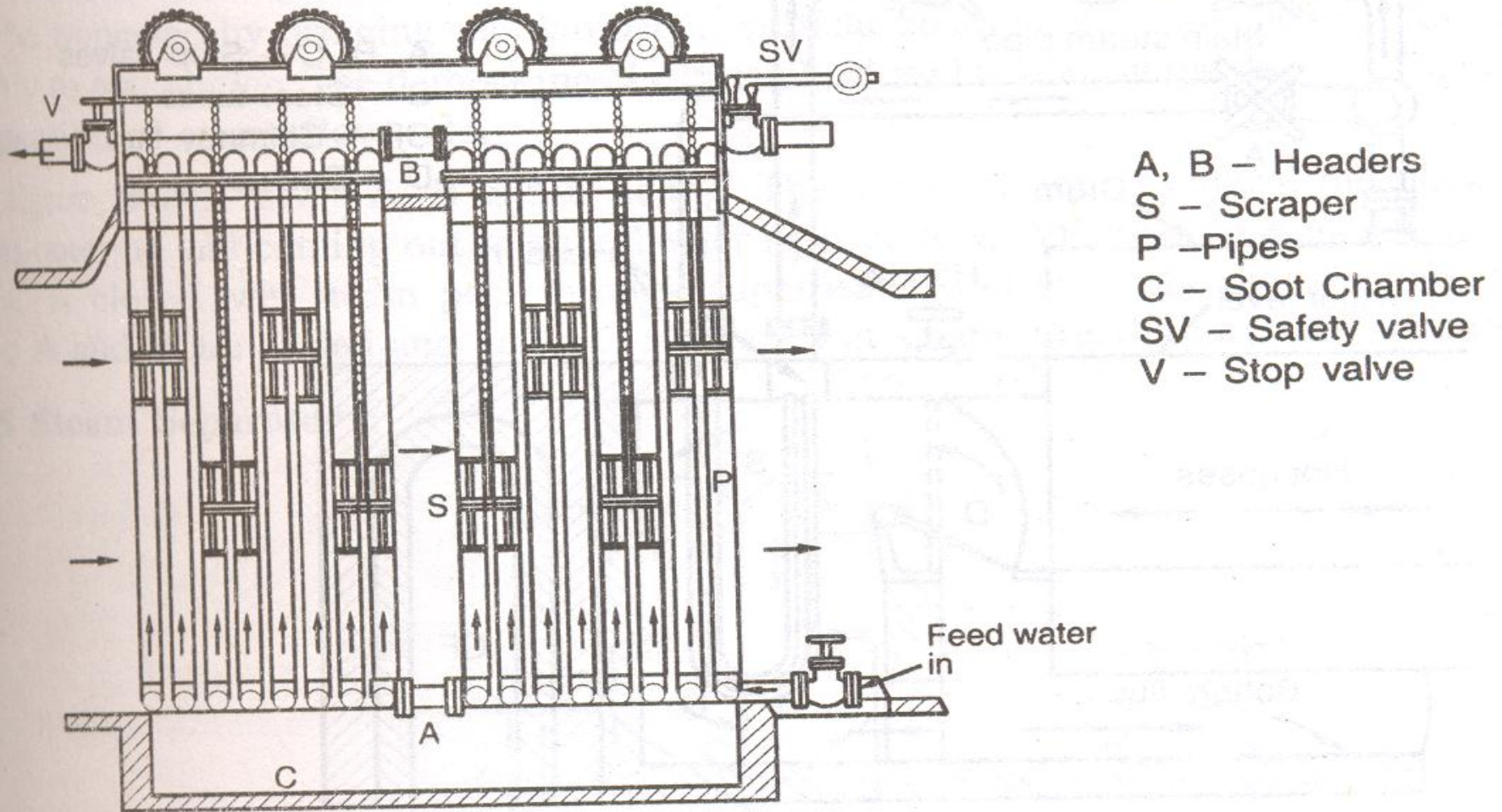


Fig. 5.28 : Economiser

Advantages and disadvantages of economiser

Advantage

- ▶ Higher feed water temp., reduce boiler thermal stresses, so boiler life increased
- ▶ Economiser utilised waste heat from fuel gases, so fuel consumption reduce.
- ▶ Increased evaporative capacity

Disadvantages

- ▶ Economiser placed at the passage of flow of flue gases, so pressure drop takes place of flue gases (loss of draught)

Exhaust steam feed water heater:

To increase temperature of feed water using heat from exhaust steam of steam turbine or steam from boiler

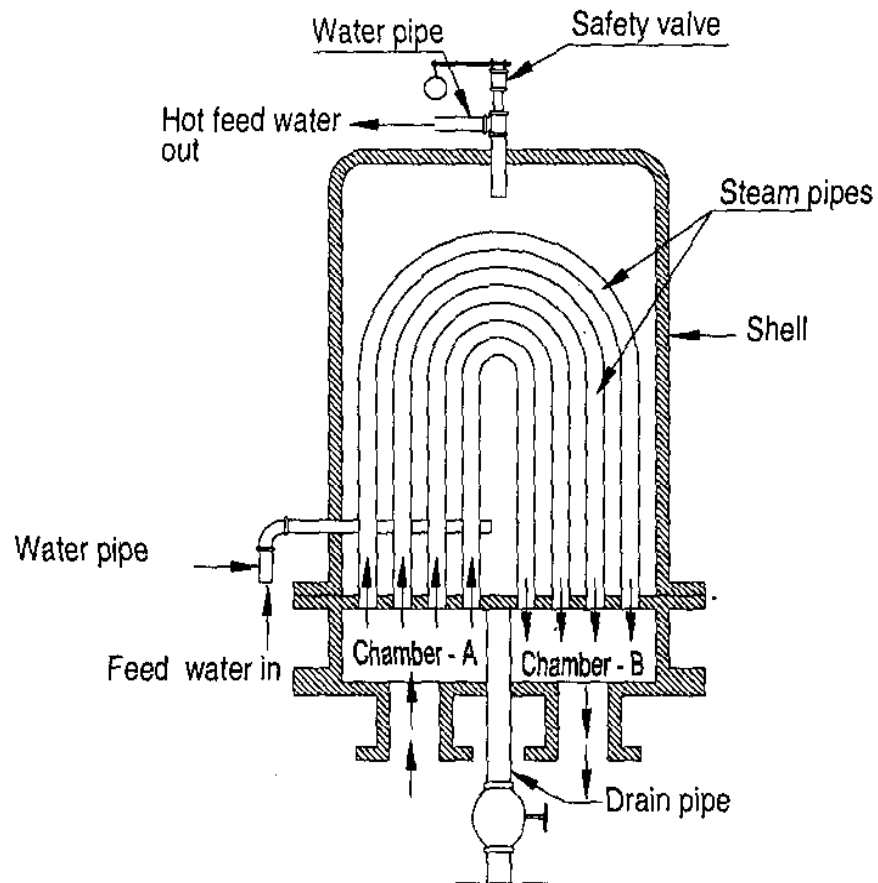


Fig. 6.28 Exhaust steam feed water heater

Super heater

to increase the stem temperature of steam above saturation point

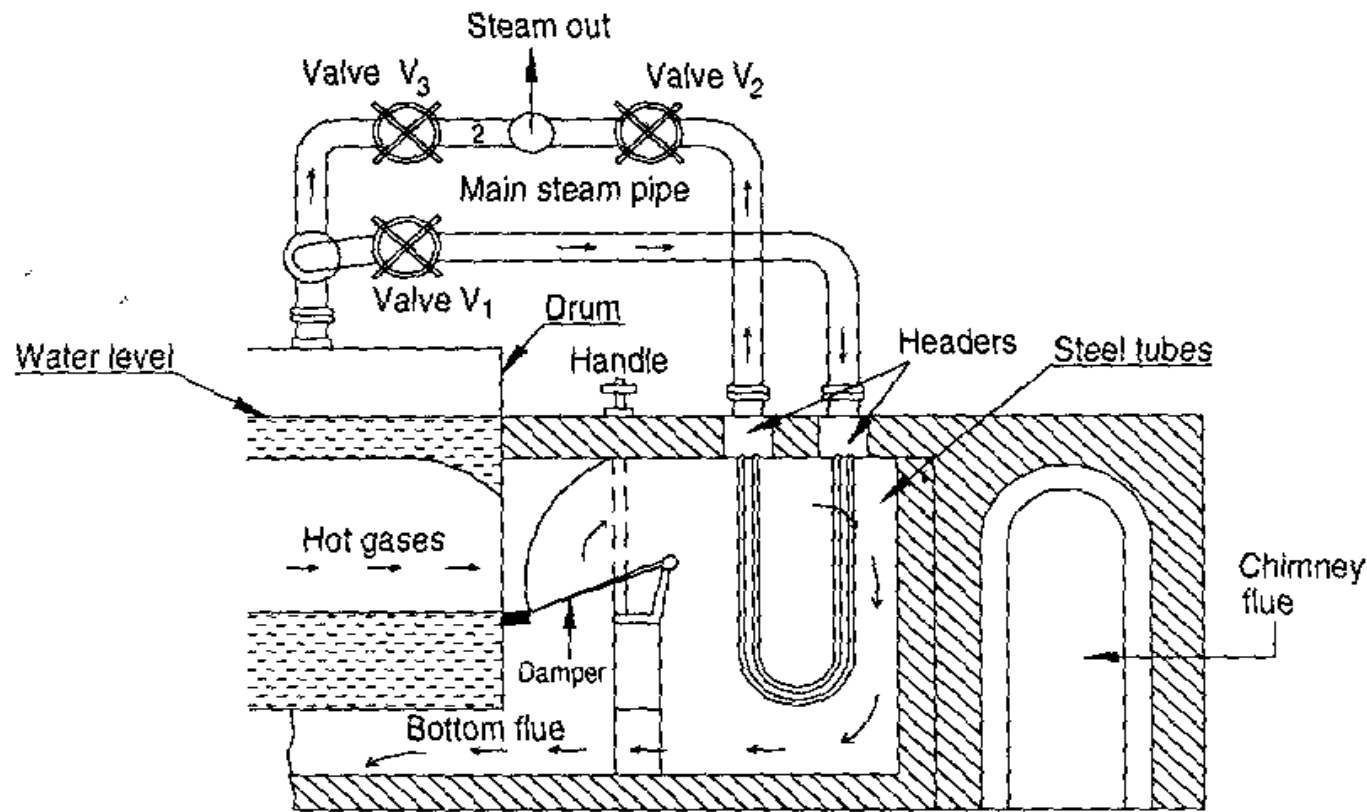


Fig. 6.29 Superheater

Thank you